CLAIMS

1. An electrode tool for electrochemical machining comprising:

an electrode substrate including a machining electrode surface;

a conductive pattern defined by a plurality of lands and grooves formed on the machining electrode surface;

an insulating resin molded integrally with the electrode substrate and filled into the grooves of the conductive pattern,

wherein the lands define a surface of the conductive pattern that is below a surface of the insulating resin filled into the grooves of the conductive pattern, and

a height difference between the surface of the conductive pattern and the surface of the insulating resin is between 1 and 5 μm.

2. The electrode tool as set forth in claim 1, wherein the insulating resin comprises a resin selected from among epoxy resin, urethane resin and polyimide resin.

3. The electrode tool as set forth in claim 1, wherein the electrode substrate comprises one of brass and austenitic stainless steel, and the insulation layer comprises an epoxy resin.

4. The electrode tool as set forth in claim 1, wherein the lands comprise deburred lands.

5. The electrode tool as set forth in claim 1, wherein the height difference between the surface of the conductive pattern and the surface of the insulating resin is between 1 and 3 μm.

6. The electrode tool as set forth in claim 1, wherein the height difference between the surface of the conductive pattern and the surface of the insulating resin is 2 μm.

7. The electrode tool as set forth in claim 1, wherein the height difference between the surface of the conductive pattern and the surface of the insulating resin is 3 μm.

8. The electrode tool as set forth in claim 1, wherein the lands have rounded edges.

9. The electrode tool as set forth in claim 1, wherein the conductive pattern reproduced on a work piece is free of groove separation breaks.

10. A method of manufacturing an electrode tool for electrochemical machining, comprising:

groove machining a machining electrode surface of an electrode substrate to form lands and grooves that define a conductive pattern;

molding the machining electrode surface with an insulating resin;

mechanically polishing a surface of the insulating resin to expose the lands of the conductive pattern; and

chemically dissolving only the lands of the conductive pattern so that a surface of the conductive pattern is below the surface of the insulating resin.

11. The method of claim 10, further comprising rounding the edges of the lands where they jut into the grooves during the groove machining.

12. The method of claim 10, wherein the chemically dissolving of only the lands of the conductive pattern comprises immersing the conductive pattern into a solution of 60% nitric acid for approximately 2 seconds and then washing the conductive pattern with pure water.

13. The method of claim 12, wherein the immersing of the conductive pattern into a solution of 60% nitric acid for approximately 2 seconds and then washing the conductive pattern with pure water removes burrs from the lands.

14. The method of claim 10, wherein the chemically dissolving only the lands of the conductive pattern so that a surface of the conductive pattern is below the surface of the insulating resin comprises chemically dissolving only the lands of the conductive pattern so that the surface of the conductive pattern is between 1 and 5 μm below the surface of the insulating resin.

15. The method of claim 10, wherein the chemically dissolving only the lands of the conductive pattern comprises chemically dissolving the lands of the conductive pattern by immersing the conductive pattern into a solution of 60% nitric acid for approximately 3 seconds and then washing the conductive pattern with pure water.

16. A method of mechanically machining a work piece with an electrode tool having a conductive pattern surface recessed from a non-conductive surface, comprising:

placing the work piece and the electrode tool apart from one another in an electrolyte solution to define a gap between the work piece and the electrode tool;

circulating the electrolyte solution through the gap; and

generating a direct electrical current through the electrode tool to the work piece to form grooves on the work piece, the grooves corresponding to the conductive pattern on the electrode tool.

17. The method of claim 16, wherein the placing of the work piece and the electrode tool apart from one another in an electrolyte solution to define a gap between the work piece and the electrode tool comprises placing the work piece and the electrode tool apart from one another in an electrolyte solution to define a gap of approximately 20-100 μm between the work piece and the electrode tool.

18. The method of claim 16, wherein the circulating of the electrolyte solution through the gap comprises circulating the electrolyte solution through the gap at a rate of between 8 to 12 m/sec.

19. The method of claim 16, wherein:

the placing of the work piece and the electrode tool apart from one another in an electrolyte solution to define a gap between the work piece and the electrode tool comprises placing the work piece and the electrode tool apart from one another in an electrolyte solution to define a gap of approximately 20-100 μm between the work piece and the electrode tool; and

the circulating of the electrolyte solution through the gap comprises circulating the electrolyte solution through the gap at a rate of between 8 to 12 m/sec.

20. The method of claim 16, wherein the generating of a direct electrical current through the electrode tool to the work piece to form grooves on the work piece comprises:

connecting a negative terminal of a direct current pulsed power supply to the electrode tool; and

connecting a positive terminal of the direct current pulsed power supply to the work piece.